CLAIMS

We claim:

1. A barrier layer for use in combination with a conductive layer, said barrier layer having a particular structure comprising:

a) a first layer of TaN_x having a thickness ranging from greater than about 10 Å to about 1,000 Å; and

b) a second layer of Ta overlying said first layer and having a thickness ranging from about 5 Å to about 500 Å.

2. The barrier layer of Claim 1, wherein the conductive layer is copper.

3. The barrier layer of Claim 1, wherein said barrier layer is used in an interconnect structure, and wherein the thickness of said TaN_x layer ranges from about 50 Å to about 1,000 Å and the thickness of said Ta layer ranges from about 20 Å to about 500 Å.

4. The barrier layer of Claim 1, wherein said barrier layer is used in a contact via structure, and wherein the thickness of said TaN_x layer ranges from about 10 Å to about 300 Å and the thickness of said Ta layer ranges from about 5 Å to about 300 Å.

5. The barrier layer of Claim 2, or Claim 3, or Claim 4, wherein x ranges from about 0.1 to about 1.5.

6. A copper interconnect structure comprising the barrier layer of Claim 2 and an overlying copper layer, wherein the Cu {111} crystallographic content of said overlying copper layer is at least 70% of the Cu {111} crystallographic content which can be obtained using a pure Ta barrier layer which is about 500 Å thick.

7. A copper contact via comprising structure including the barrier layer of Claim 2 and a copper fill, wherein the copper fill layer Cu {111} crystallographic content is at least 70% of the Cu {111} crystallographic content which can be obtained using a pure Ta barrier layer which is about 250 Å thick.

8. A method of producing a barrier layer useful in combination with a conductive layer, said method comprising the steps of:

a) depositing a first layer of TaN_x having a thickness ranging from greater than about 10 Å to about 1,000 Å; and

b) depositing a second layer of Ta having a thickness ranging from about 5 Å to about 500 Å.

9. The method of Claim 8, wherein the conductive layer is copper.

10. The method of Claim 8, wherein said first layer of TaN_x is deposited upon a substrate having a substrate temperature ranging from about 25°C to about 500°C.

11. The method of Claim 8, wherein said second layer of Ta is deposited upon a substrate having a substrate temperature ranging from about 25°C to about 500°C.

12. The method of Claim 8, wherein said barrier layer is used in an interconnect structure, and wherein the thickness of said TaN_x layer ranges from about 50 Å to about 1,000 Å and the thickness of said Ta layer ranges from about 20 Å to about 500 Å.

Sub A3

13. The method of Claim 8, wherein said barrier layer is used in a contact via structure, and wherein the thickness of said TaN_x layer ranges from about 10 Å to about 300 Å and the thickness of said Ta layer ranges from about 5 Å to about 300 Å.

14. The method of Claim 8, or Claim 12, or Claim 13, where x ranges from about 0.1 to about 1.5.

15. The method of Claim 8, wherein at least a portion of said Ta layer is deposited using a traditional, standard sputtering technique.

16. The method of Claim 12, wherein at least a portion of said Ta layer is deposited using a traditional, standard sputtering technique.

Sub A4

17. The method of Claim 8, wherein at least a portion of the TaN_x layer is deposited using a traditional, standard sputtering technique.

18. The method of Claim 8, wherein at least a portion of said Ta layer is deposited using ion-deposition sputtering.

19. The method of Claim 13, wherein at least a portion of said Ta layer is deposited using ion-deposition sputtering.

20. The method of Claim 8, wherein at least a portion of the TaN_x layer is deposited using ion-deposition sputteirng.

21. A method of producing a copper interconnect structure comprising the barrier layer of Claim 1 and an overlying copper layer, wherein the Cu {111} crystallographic content of said overlying copper layer is at least 70 % of the Cu {111} crystallographic content which can be obtained by depositing said copper layer using a pure Ta barrier layer which is about 500 Å thick, said method comprising the steps of:

a) depositing a first layer of TaN_x having a thickness ranging from greater than about 50 Å to about 1,000 Å;

b) depositing a second layer of Ta having a thickness ranging from about 5 Å to about 500 Å over the surface of said first layer of TaN_x; and

c) depositing a third layer of copper over the surface of said second layer of Ta, wherein at least a portion of said third layer of copper is deposited using a physical vapor deposition technique, and wherein the substrate temperature at which said third layer of copper is deposited is less than about 500°C.

22. The method of Claim 21, wherein said copper interconnect structure is annealed at a temperature of less than about 500°C.

23. A method of producing a copper-comprising contact via structure comprising the barrier layer of Claim 1 and an overlying copper layer, wherein the Cu {111} crystallographic content of said overlying copper layer is at least 70% of the Cu {111} crystallographic content which can be obtained by depositing said copper layer using a pure Ta barrier layer which is about 300 Å thick, said method comprising the steps of:

a) depositing a first layer of TaN_x having a thickness ranging from greater than about 10 Å to about 300 Å;

b) depositing a second layer of Ta having a thickness ranging from about 5 Å to about 300 Å over the surface of said first layer of TaN_x; and

c) depositing a third layer of copper over the surface of said second layer of Ta, wherein at least a portion of said third layer of copper is deposited using a physical vapor deposition technique, and wherein the substrate temperature at which said third layer of copper is deposited is less than about 500°C.

24. The method of Claim 23, wherein said contact-comprising structure is annealed at a temperature of less than about 500°C.

25. The method of Claim 23, wherein said copper layer is deposited at a temperature of less than about 300°C.

26. The method of Claim 25, wherein said structure is annealed at a temperature of less than about 500°C.

27. A method of producing a copper-comprising contact structure including the barrier layer of Claim 1 and an overlying copper layer, wherein the Cu {111} crystallographic content of said overlying copper layer is at least 70% of the Cu {111} crystallographic content which can be obtained by depositing said copper layer using a pure Ta barrier layer which is about 300 Å thick, said method comprising the steps of:

Sub A7

a) depositing a first layer of TaN_x having a thickness ranging from greater than about 10 Å to about 300 Å;

b) depositing a second layer of Ta having a thickness ranging from about 5 Å to about 300 Å over the surface of said first layer of TaN_x; and

c) depositing a third layer of copper over the surface of said second layer of Ta, wherein at least a portion of said third layer of copper is deposited using a physical vapor deposition technique, and wherein the substrate temperature at which said third layer of copper is deposited is less than about 500°C,

wherein at least a portion of said first layer, or said second layer, or said third layer, or a combination thereof, is deposited using ion-deposition sputtering.